

# STARPOWER

SEMICONDUCTOR

IGBT

## GD50PIT120C6S\_T4

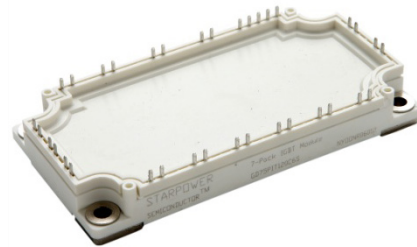
1200V/50A PIM in one-package

### General Description

STARPOWER IGBT Power Module provides ultra low conduction loss as well as short circuit ruggedness. They are designed for the applications such as general inverters and UPS.

### Features

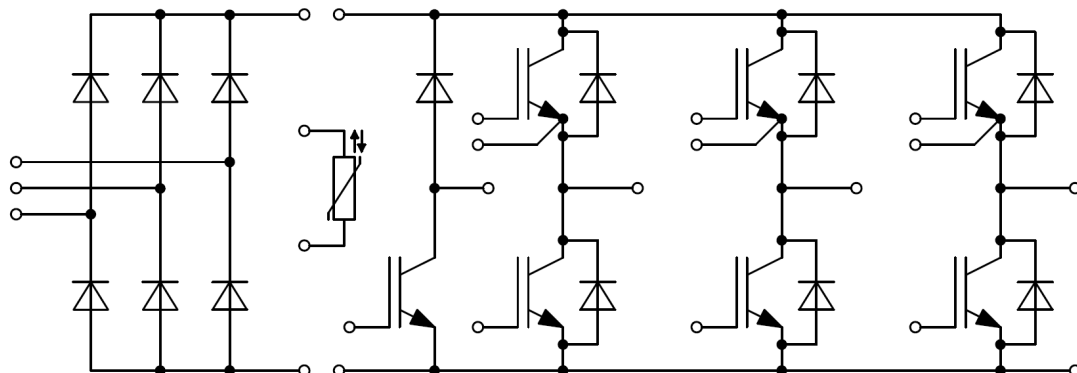
- Low  $V_{CE(sat)}$  Trench IGBT technology
- 10 $\mu$ s short circuit capability
- $V_{CE(sat)}$  with positive temperature coefficient
- Maximum junction temperature 175°C
- Low inductance case
- Fast & soft reverse recovery anti-parallel FWD
- Isolated copper baseplate using DBC technology



### Typical Applications

- Inverter for motor drive
- AC and DC servo drive amplifier
- Uninterruptible power supply

### Equivalent Circuit Schematic



**Absolute Maximum Ratings**  $T_C=25^{\circ}\text{C}$  unless otherwise noted**IGBT-inverter**

Symbol	Description	Value	Unit
$V_{CES}$	Collector-Emitter Voltage	1200	V
$V_{GES}$	Gate-Emitter Voltage	$\pm 20$	V
$I_C$	Collector Current @ $T_C=25^{\circ}\text{C}$	80	A
	@ $T_C=100^{\circ}\text{C}$	50	
$I_{CM}$	Pulsed Collector Current $t_p=1\text{ms}$	100	A
$P_D$	Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$	321	W

**Diode-inverter**

Symbol	Description	Value	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	1200	V
$I_F$	Diode Continuous Forward Current	50	A
$I_{FM}$	Diode Maximum Forward Current $t_p=1\text{ms}$	100	A

**Diode-rectifier**

Symbol	Description	Value	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	1600	V
$I_O$	Average Output Current 50Hz/60Hz,sine wave	50	A
$I_{FSM}$	Surge Forward Current $V_R=0\text{V}, t_p=10\text{ms}, T_j=45^{\circ}\text{C}$	850	A
$I^2t$	$I^2t$ -value, $V_R=0\text{V}, t_p=10\text{ms}, T_j=45^{\circ}\text{C}$	3610	$\text{A}^2\text{s}$

**IGBT-brake**

Symbol	Description	Value	Unit
$V_{CES}$	Collector-Emitter Voltage	1200	V
$V_{GES}$	Gate-Emitter Voltage	$\pm 30$	V
$I_C$	Collector Current @ $T_C=25^{\circ}\text{C}$	50	A
	@ $T_C=100^{\circ}\text{C}$	25	
$I_{CM}$	Pulsed Collector Current $t_p=1\text{ms}$	50	A
$P_D$	Maximum Power Dissipation @ $T_j=175^{\circ}\text{C}$	202	W

**Diode-brake**

Symbol	Description	Value	Unit
$V_{RRM}$	Repetitive Peak Reverse Voltage	1200	V
$I_F$	Diode Continuous Forward Current	25	A
$I_{FM}$	Diode Maximum Forward Current $t_p=1\text{ms}$	50	A

**Module**

Symbol	Description	Value	Unit
$T_{jmax}$	Maximum Junction Temperature(inverter,brake)	175	$^{\circ}\text{C}$
	Maximum Junction Temperature(rectifier)	150	
$T_{jop}$	Operating Junction Temperature	-40 to +150	$^{\circ}\text{C}$
$T_{STG}$	Storage Temperature Range	-40 to +125	$^{\circ}\text{C}$
$V_{ISO}$	Isolation Voltage RMS, $f=50\text{Hz}, t=1\text{min}$	4000	V

**IGBT-inverter Characteristics**  $T_C=25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit	
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C=50\text{A}, V_{GE}=15\text{V}, T_j=25^\circ\text{C}$		1.85	2.30	V	
		$I_C=50\text{A}, V_{GE}=15\text{V}, T_j=125^\circ\text{C}$		2.15			
		$I_C=50\text{A}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}$		2.25			
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=1.7\text{mA}, V_{CE}=V_{GE}, T_j=25^\circ\text{C}$	5.3	5.8	6.3	V	
$I_{CES}$	Collector Cut-Off Current	$V_{CE}=V_{CES}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$			1.0	mA	
$I_{GES}$	Gate-Emitter Leakage Current	$V_{GE}=V_{GES}, V_{CE}=0\text{V}, T_j=25^\circ\text{C}$			100	nA	
$R_{Gint}$	Internal Gate Resistance			4		$\Omega$	
$C_{ies}$	Input Capacitance	$V_{CE}=25\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$		2.80		nF	
$C_{res}$	Reverse Transfer Capacitance				0.10		nF
$Q_G$	Gate Charge	$V_{GE}=-15\dots+15\text{V}$		0.38		$\mu\text{C}$	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=600\text{V}, I_C=50\text{A}, R_G=15\Omega, V_{GE}=\pm 15\text{V}, T_j=25^\circ\text{C}$		236		ns	
$t_r$	Rise Time			60		ns	
$t_{d(off)}$	Turn-Off Delay Time			281		ns	
$t_f$	Fall Time			196		ns	
$E_{on}$	Turn-On Switching Loss			5.60		mJ	
$E_{off}$	Turn-Off Switching Loss			2.75		mJ	
$t_{d(on)}$	Turn-On Delay Time		$V_{CC}=600\text{V}, I_C=50\text{A}, R_G=15\Omega, V_{GE}=\pm 15\text{V}, T_j=125^\circ\text{C}$		243		ns
$t_r$	Rise Time				64		ns
$t_{d(off)}$	Turn-Off Delay Time			378		ns	
$t_f$	Fall Time			302		ns	
$E_{on}$	Turn-On Switching Loss			7.56		mJ	
$E_{off}$	Turn-Off Switching Loss			4.48		mJ	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=600\text{V}, I_C=50\text{A}, R_G=15\Omega, V_{GE}=\pm 15\text{V}, T_j=150^\circ\text{C}$			247		ns
$t_r$	Rise Time				66		ns
$t_{d(off)}$	Turn-Off Delay Time			490		ns	
$t_f$	Fall Time			327		ns	
$E_{on}$	Turn-On Switching Loss			8.20		mJ	
$E_{off}$	Turn-Off Switching Loss			5.00		mJ	
$I_{SC}$	SC Data		$t_p \leq 10\mu\text{s}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}, V_{CC}=900\text{V}, V_{CEM} \leq 1200\text{V}$		180		A

**Diode-inverter Characteristics**  $T_C=25^{\circ}\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_F$	Diode Forward Voltage	$I_C=50\text{A}, V_{GE}=0\text{V}, T_j=25^{\circ}\text{C}$		1.70	2.15	V
		$I_C=50\text{A}, V_{GE}=0\text{V}, T_j=125^{\circ}\text{C}$		1.65		
		$I_C=50\text{A}, V_{GE}=0\text{V}, T_j=150^{\circ}\text{C}$		1.65		
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=50\text{A},$ $-di/dt=1400\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^{\circ}\text{C}$		5.5		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			54		A
$E_{rec}$	Reverse Recovery Energy			1.83		mJ
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=50\text{A},$ $-di/dt=1400\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=125^{\circ}\text{C}$		8.8		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			61		A
$E_{rec}$	Reverse Recovery Energy			3.02		mJ
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=50\text{A},$ $-di/dt=1400\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^{\circ}\text{C}$		10.2		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			64		A
$E_{rec}$	Reverse Recovery Energy			3.82		mJ

**Diode-rectifier Characteristics**  $T_C=25^{\circ}\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_F$	Diode Forward Voltage	$I_C=50\text{A}, T_j=150^{\circ}\text{C}$		1.03		V
$I_R$	Reverse Current	$T_j=150^{\circ}\text{C}, V_R=1600\text{V}$			1.5	mA

**IGBT-brake Characteristics**  $T_C=25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit	
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C=25\text{A}, V_{GE}=15\text{V}, T_j=25^\circ\text{C}$		1.70	2.15	V	
		$I_C=25\text{A}, V_{GE}=15\text{V}, T_j=125^\circ\text{C}$		1.95			
		$I_C=25\text{A}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}$		2.00			
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=1.0\text{mA}, V_{CE}=V_{GE}, T_j=25^\circ\text{C}$	5.0	5.9	6.5	V	
$I_{CES}$	Collector Cut-Off Current	$V_{CE}=V_{CES}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$			1.0	mA	
$I_{GES}$	Gate-Emitter Leakage Current	$V_{GE}=V_{GES}, V_{CE}=0\text{V}, T_j=25^\circ\text{C}$			100	nA	
$R_{Gint}$	Internal Gate Resistance			/		$\Omega$	
$C_{ies}$	Input Capacitance	$V_{CE}=30\text{V}, f=1\text{MHz}, V_{GE}=0\text{V}$		2.40		nF	
$C_{res}$	Reverse Transfer Capacitance			0.08		nF	
$Q_G$	Gate Charge	$V_{GE}=15\text{V}$		0.16		$\mu\text{C}$	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=600\text{V}, I_C=25\text{A}, R_G=18\Omega, V_{GE}=\pm 15\text{V}, T_j=25^\circ\text{C}$		140		ns	
$t_r$	Rise Time			26		ns	
$t_{d(off)}$	Turn-Off Delay Time			201		ns	
$t_f$	Fall Time			337		ns	
$E_{on}$	Turn-On Switching Loss			1.66		mJ	
$E_{off}$	Turn-Off Switching Loss			1.64		mJ	
$t_{d(on)}$	Turn-On Delay Time		$V_{CC}=600\text{V}, I_C=25\text{A}, R_G=18\Omega, V_{GE}=\pm 15\text{V}, T_j=125^\circ\text{C}$		143		ns
$t_r$	Rise Time				28		ns
$t_{d(off)}$	Turn-Off Delay Time			216		ns	
$t_f$	Fall Time			400		ns	
$E_{on}$	Turn-On Switching Loss			1.93		mJ	
$E_{off}$	Turn-Off Switching Loss			2.35		mJ	
$t_{d(on)}$	Turn-On Delay Time	$V_{CC}=600\text{V}, I_C=25\text{A}, R_G=18\Omega, V_{GE}=\pm 15\text{V}, T_j=150^\circ\text{C}$			145		ns
$t_r$	Rise Time				30		ns
$t_{d(off)}$	Turn-Off Delay Time			218		ns	
$t_f$	Fall Time			525		ns	
$E_{on}$	Turn-On Switching Loss			2.21		mJ	
$E_{off}$	Turn-Off Switching Loss			2.71		mJ	
$I_{SC}$	SC Data		$t_p \leq 10\mu\text{s}, V_{GE}=15\text{V}, T_j=150^\circ\text{C}, V_{CC}=900\text{V}, V_{CEM} \leq 1200\text{V}$		100		A

**Diode-brake Characteristics**  $T_C=25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_F$	Diode Forward Voltage	$I_C=25\text{A}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$		2.10	2.55	V
		$I_C=25\text{A}, V_{GE}=0\text{V}, T_j=125^\circ\text{C}$		2.15		
		$I_C=25\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$		2.15		
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=25\text{A},$ $-di/dt=900\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=25^\circ\text{C}$		1.3		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			31		A
$E_{rec}$	Reverse Recovery Energy			0.68		mJ
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=25\text{A},$ $-di/dt=900\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=125^\circ\text{C}$		2.2		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			38		A
$E_{rec}$	Reverse Recovery Energy			1.46		mJ
$Q_r$	Recovered Charge	$V_R=600\text{V}, I_F=25\text{A},$ $-di/dt=900\text{A}/\mu\text{s}, V_{GE}=-15\text{V}$ $T_j=150^\circ\text{C}$		2.4		$\mu\text{C}$
$I_{RM}$	Peak Reverse Recovery Current			40		A
$E_{rec}$	Reverse Recovery Energy			1.91		mJ

**NTC Characteristics**  $T_C=25^\circ\text{C}$  unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$R_{25}$	Rated Resistance			5.0		$\text{k}\Omega$
$\Delta R/R$	Deviation of $R_{100}$	$T_C=100^\circ\text{C}, R_{100}=493.3\Omega$	-5		5	%
$P_{25}$	Power Dissipation				20.0	mW
$B_{25/50}$	B-value	$R_2=R_{25}\exp[B_{25/50}(1/T_2-1/(298.15\text{K}))]$		3375		K

**Module Characteristics**  $T_c=25^{\circ}\text{C}$  unless otherwise noted

Symbol	Parameter	Min.	Typ.	Max.	Unit
$L_{CE}$	Stray Inductance		60		nH
$R_{CC'+EE'}$ $R_{AA'+CC'}$	Module Lead Resistance, Terminal to Chip		4.00 2.00		m $\Omega$
$R_{\theta JC}$	Junction-to-Case (per IGBT-inverter) Junction-to-Case (per Diode-inverter) Junction-to-Case (per Diode-rectifier) Junction-to-Case (per IGBT-brake-chopper) Junction-to-Case (per Diode-brake-chopper)			0.467 0.676 0.635 0.742 1.267	K/W
$R_{\theta CS}$	Case-to-Sink (per IGBT-inverter) Case-to-Sink (per Diode-inverter) Case-to-Sink (per Diode-rectifier) Case-to-Sink (per IGBT-brake-chopper) Case-to-Sink (per Diode-brake-chopper)		0.140 0.203 0.190 0.222 0.380		K/W
$R_{\theta CS}$	Case-to-Sink		0.009		K/W
M	Mounting Torque, Screw:M5	3.0		6.0	N.m
G	Weight of Module		300		g

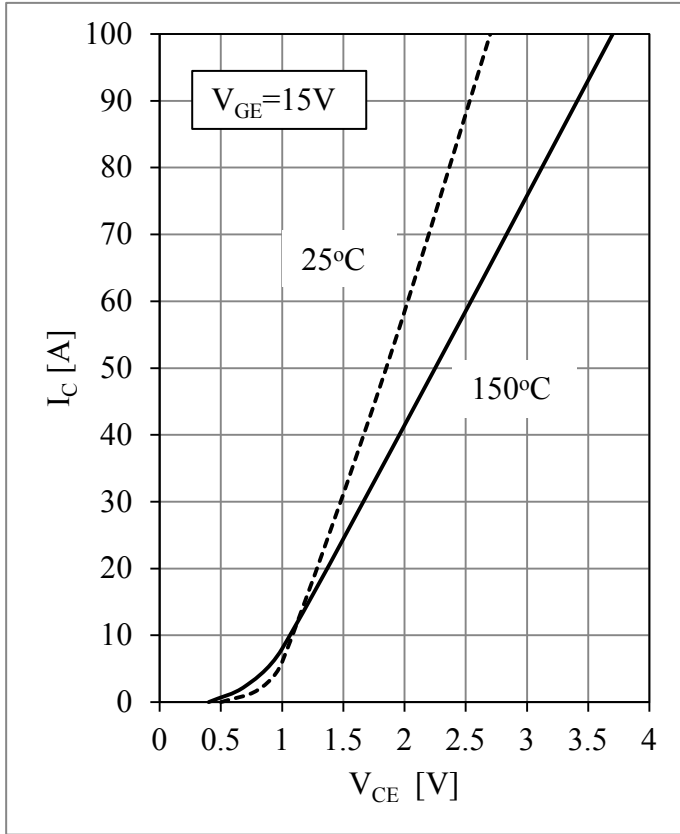


Fig 1. IGBT-inverter Output Characteristics

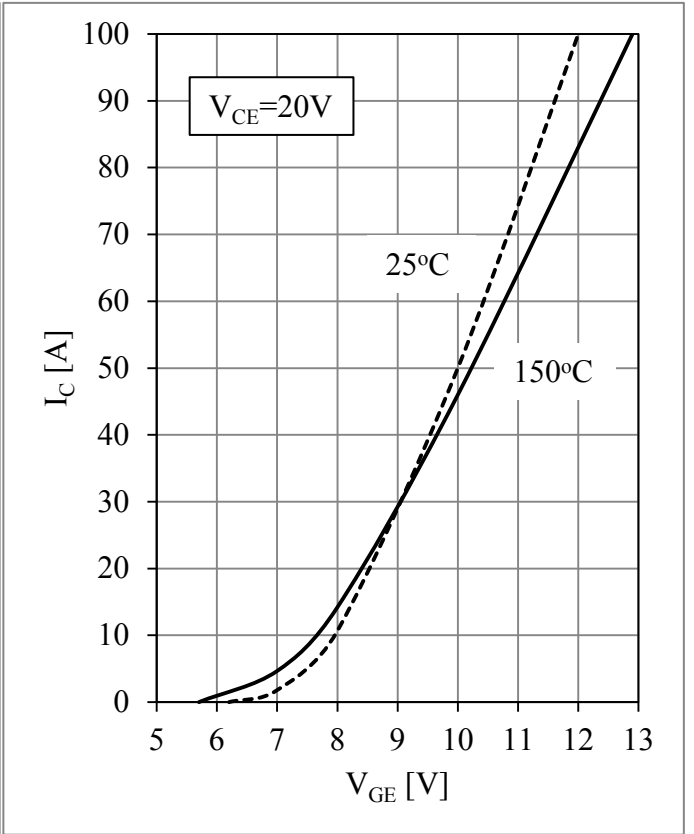


Fig 2. IGBT-inverter Transfer Characteristics

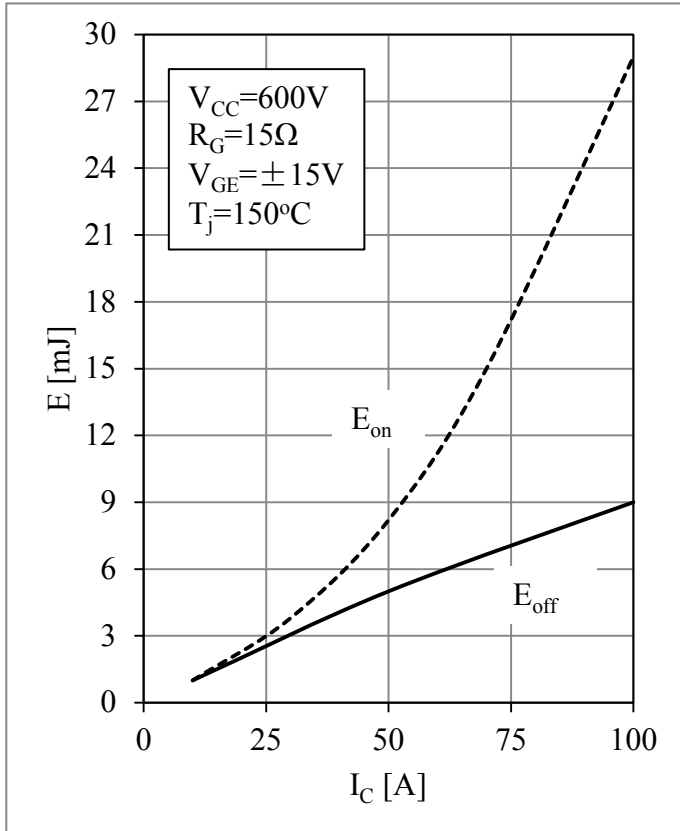


Fig 3. IGBT-inverter Switching Loss vs.  $I_C$

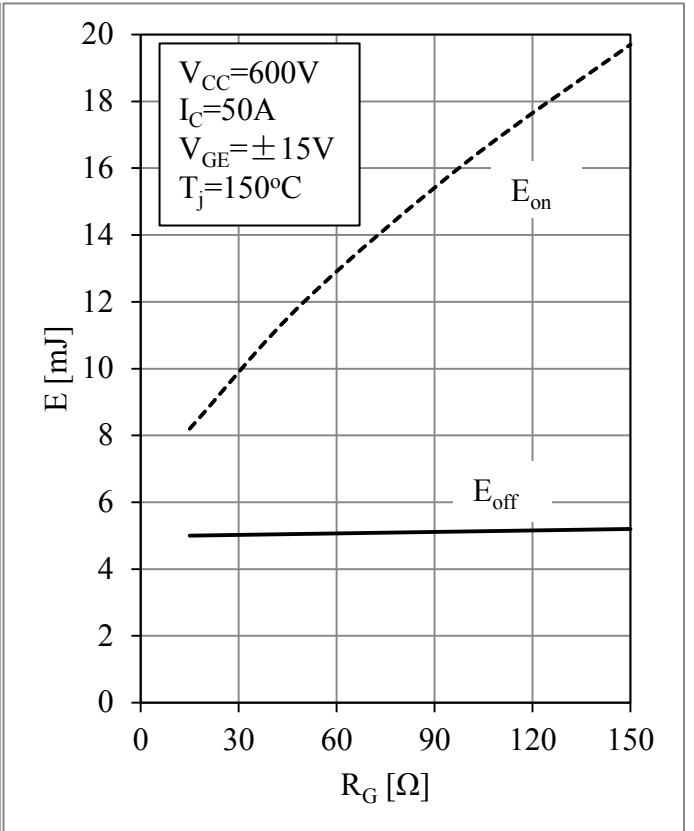


Fig 4. IGBT-inverter Switching Loss vs.  $R_G$



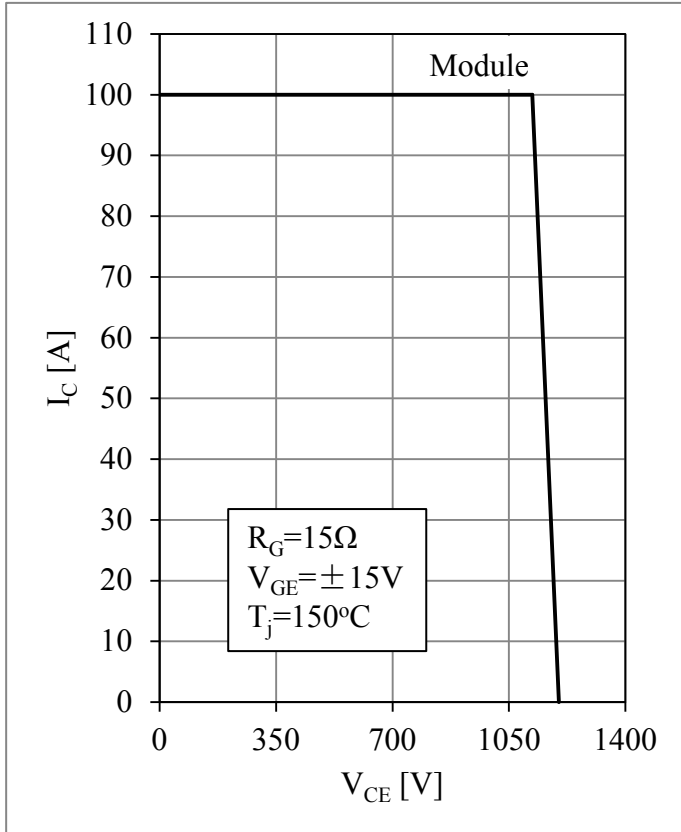


Fig 5. IGBT-inverter RBSOA

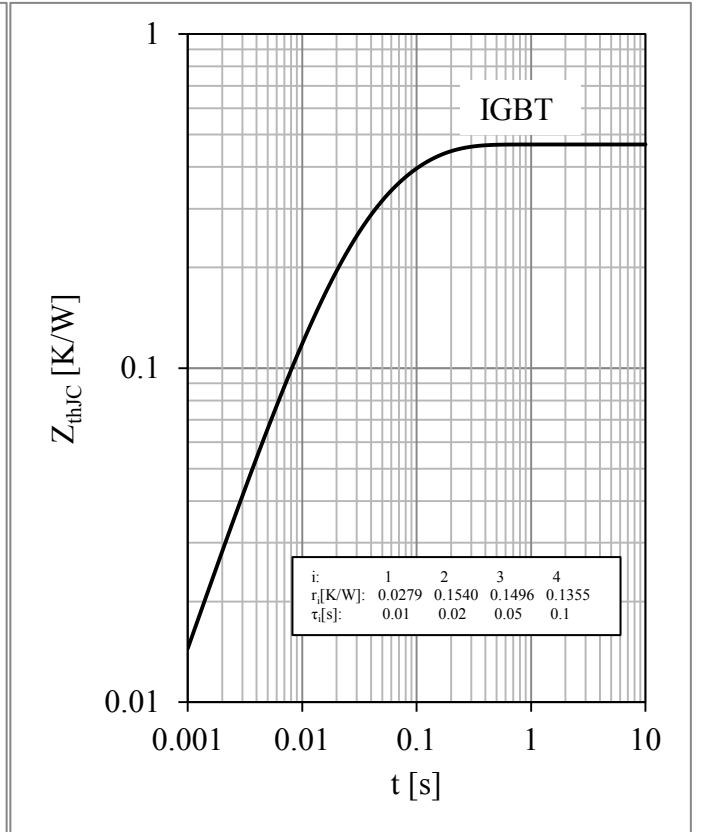


Fig 6. IGBT-inverter Transient Thermal Impedance

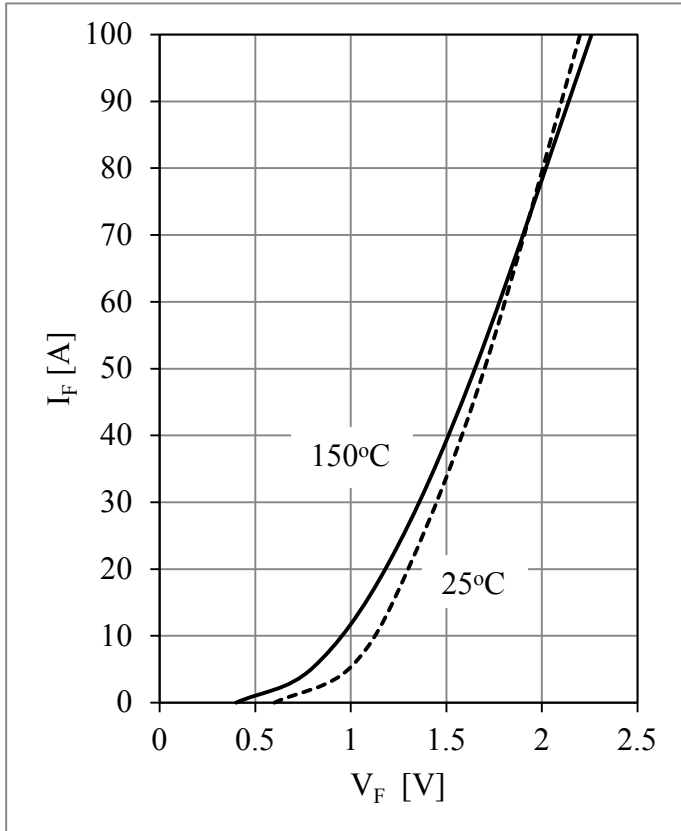


Fig 7. Diode-inverter Forward Characteristics

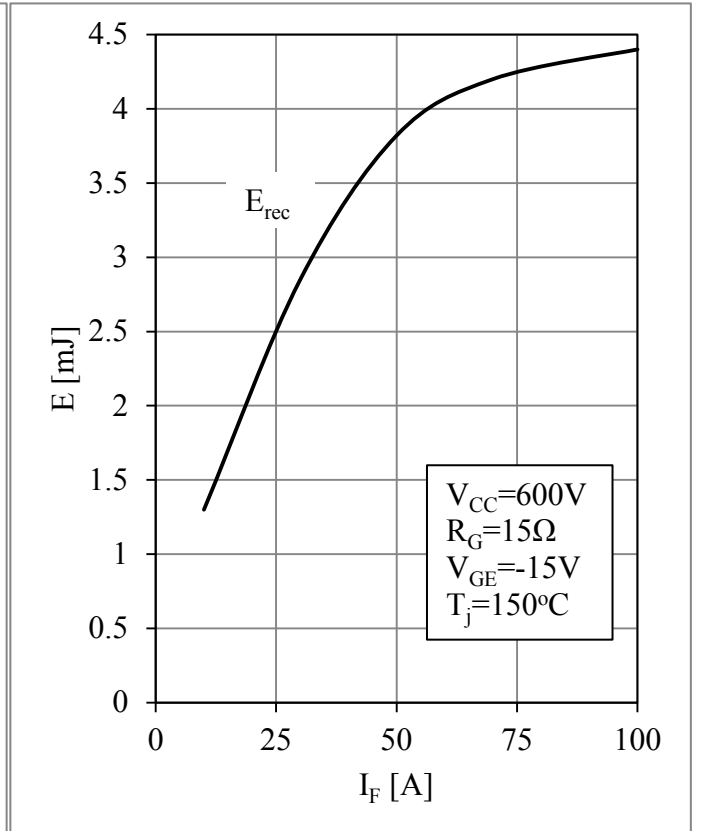


Fig 8. Diode-inverter Switching Loss vs.  $I_F$

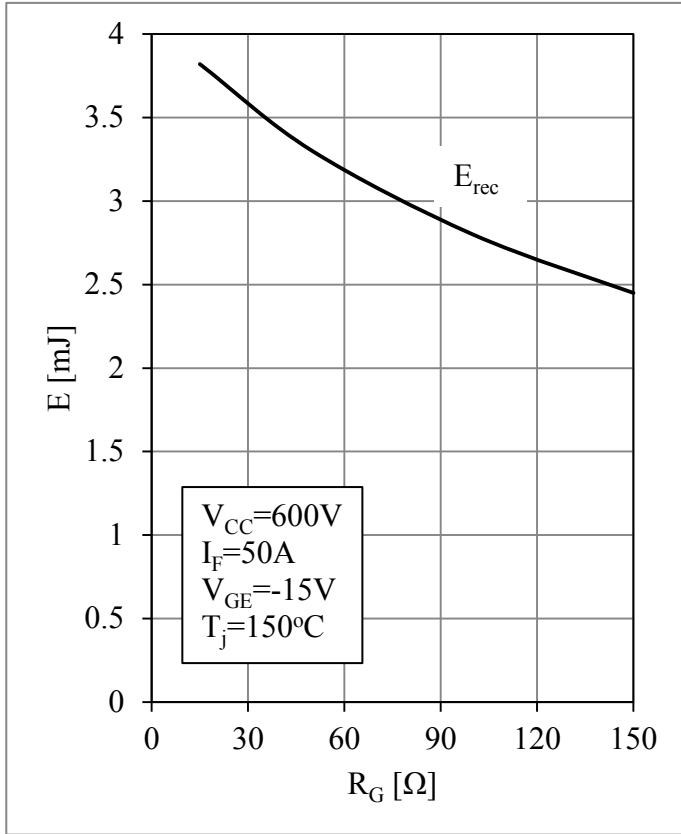


Fig 9. Diode-inverter Switching Loss vs.  $R_G$

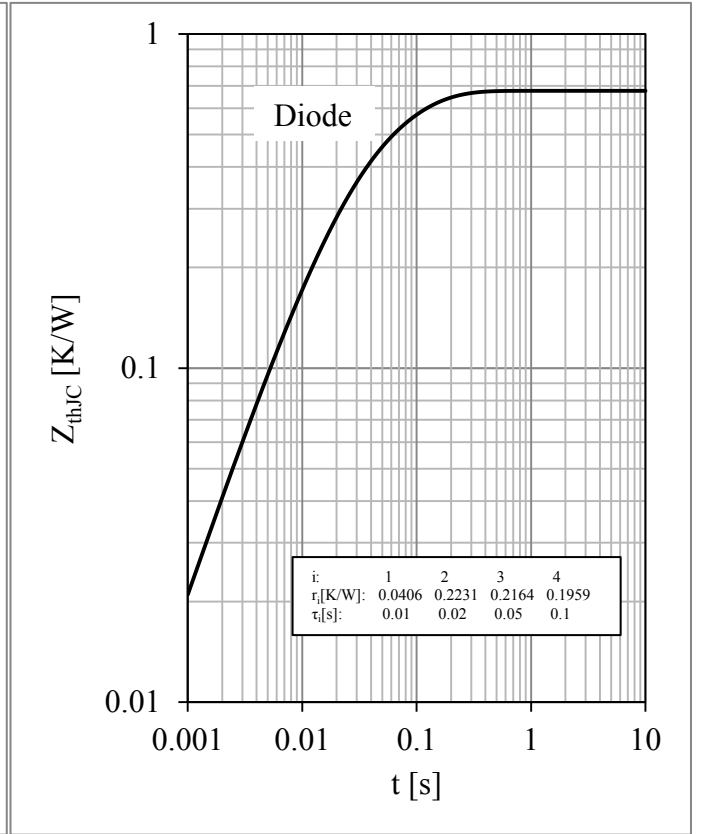


Fig 10. Diode-inverter Transient Thermal Impedance

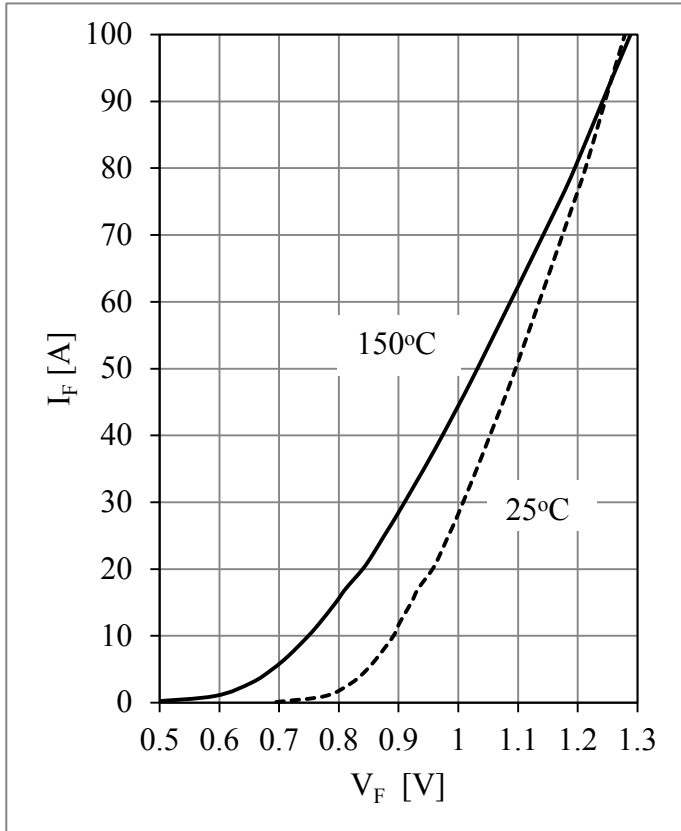


Fig 11. Diode-rectifier Forward Characteristics

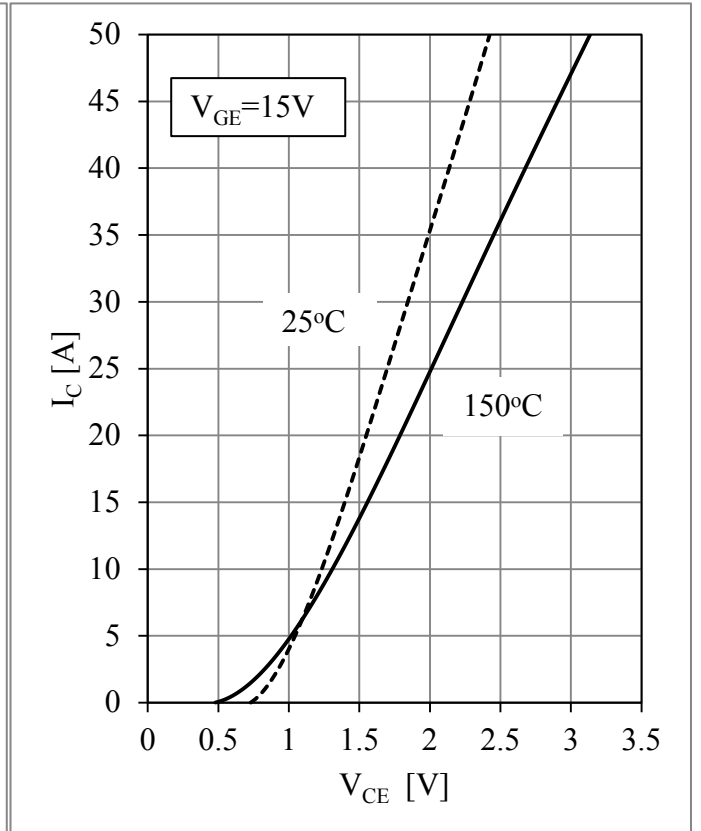


Fig 12. IGBT-brake-chopper Output Characteristics

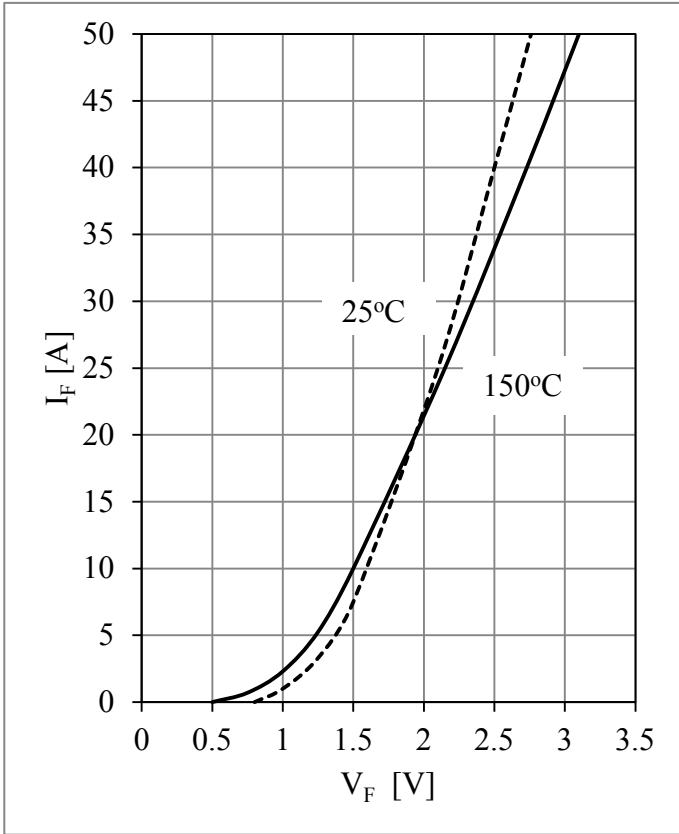


Fig 13. Diode-brake-chopper Forward Characteristics

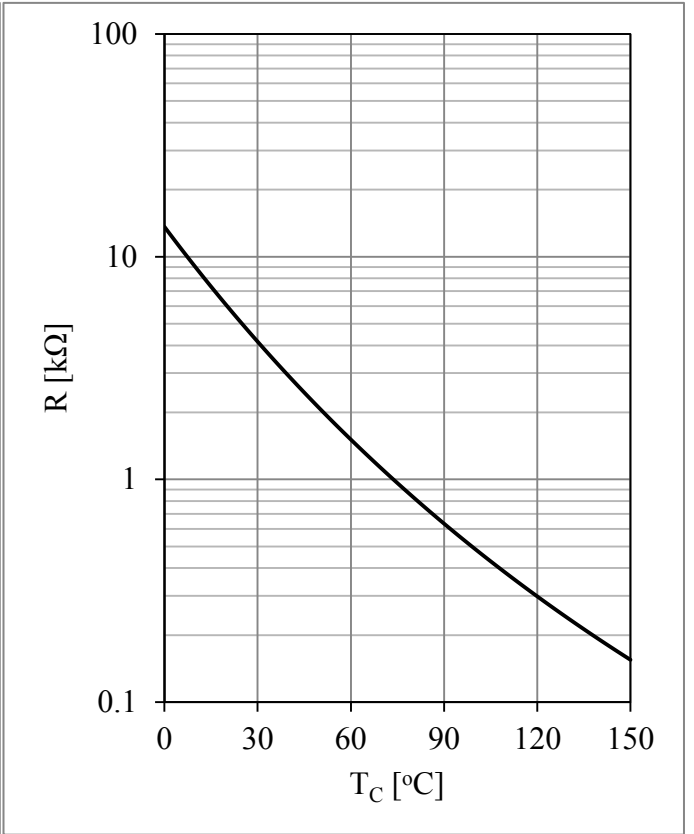
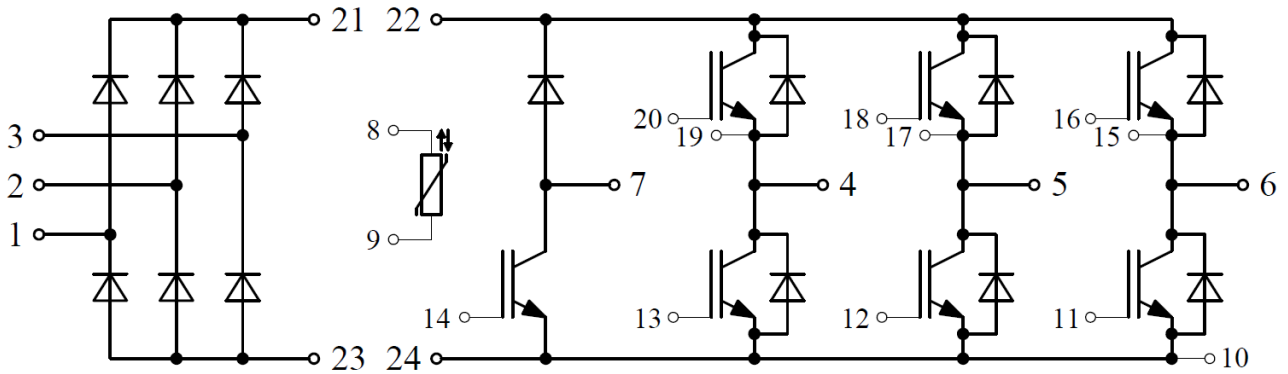


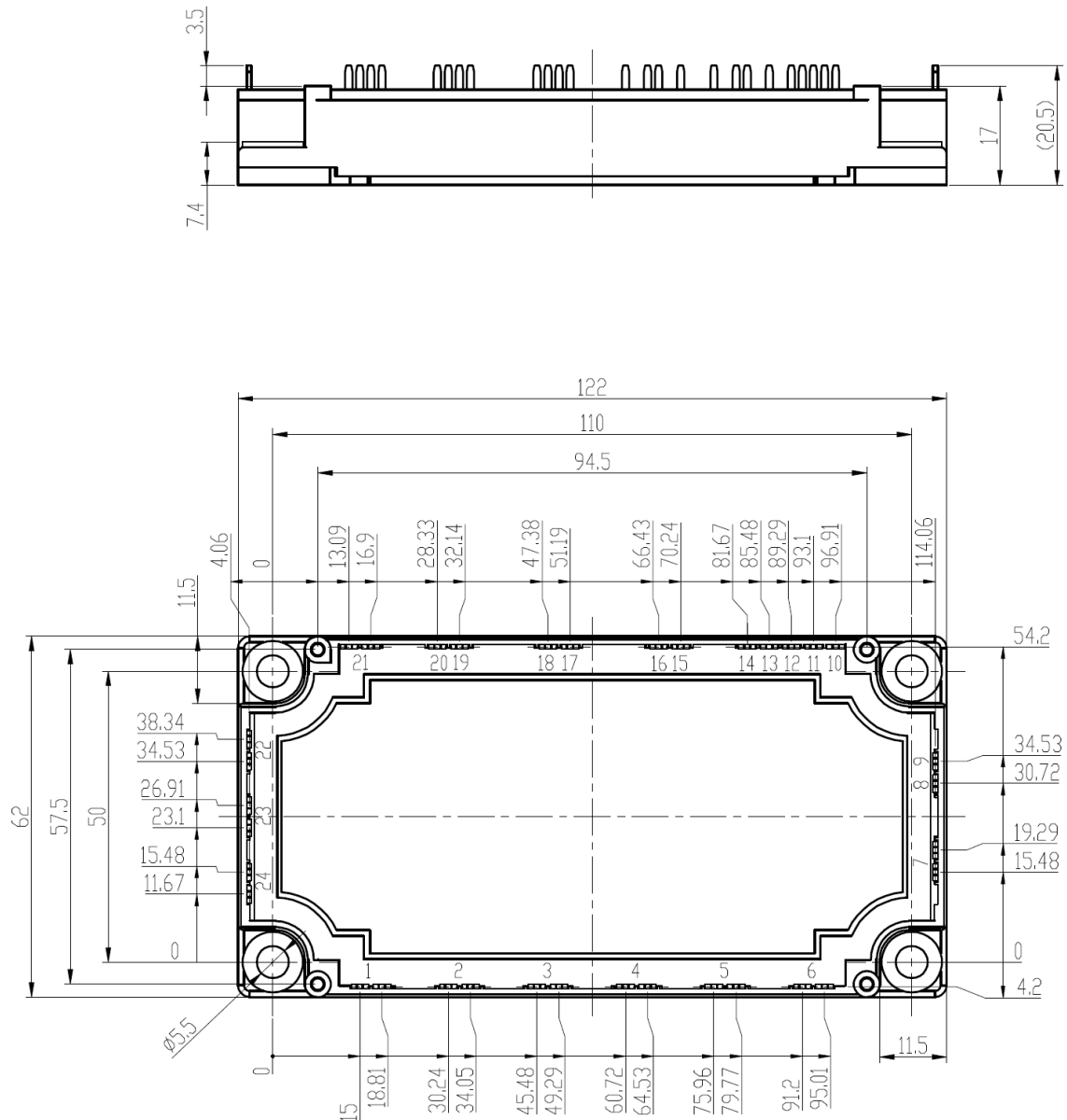
Fig 14. NTC Temperature Characteristic

**Circuit Schematic**



**Package Dimensions**

Dimensions in Millimeters



## Terms and Conditions of Usage

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